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## A NEW CLASSIFICATION OF THE UREDINALES.

BY J. C. ARTHUR.

Separates of the paper on *Eine Klassifikation der Uredineen*, read by the present writer before the International Botanical Congress at Vienna in July, 1905, were distributed early in August of the present year to many Journals and Libraries, and to a large number of mycologists. Some of the phylogenetic reasons which are made the basis of this latest attempt at a natural arrangement of the genera of rusts have been more or less fully stated in other communications already before the public. The present occasion may be seized to state some of the aids and difficulties that will beset the practical acceptance of the classification.

The simplicity of the old order of things disappears in this new arrangement, and herein will doubtless arise one of the strongest protests against it. When nine-tenths of all forms of rusts usually met with were easily assigned to the *Uromyces-Puccinia* group, and if they had one-celled teliospores were species of *Uromyces*, or two-celled teliospores were species of *Puccinia*, or if they happened to be aecia were species of *Aecidium*, the naming of rusts seemed an easy matter to the casual student. But in the new system it is essential that something of the life history be known, including the number of spore forms, and the structure of the sorus. Before, any species with a two-celled, stalked teliospore might be safely called a *Puccinia*; but now, such a species may rest in any one of thirteen genera. Before, it did not matter whether pycnia (spermogonia) accompanied the telia, or other spore stages, or not; but now such association is often of fundamental importance in the location of a species in the system. Heretofore, the structure of the urediniosorus has been of slight systematic value; now, examination of this feature alone may place the species in the correct genus, or within a small group of genera. Such requirements for the naming of collections necessitate a more intimate knowledge of the rusts as a whole, some insight into their life-history and some appreciation of their structure. For this reason the system may not for a time prove as acceptable as the one in present use.

There are, however, some short cuts to sufficient information to enable one to name his collections. Thus, telia associated with pycnia may be safely assumed to belong to a genus in which aecia and uredinia are wanting, or at most so little developed as to be of no taxonomic importance. In like manner pycnia associated with uredinia, the so-called primary uredinia, may be assumed to indicate a genus in which aecia are wanting. If aecia show telia arising within or about them from the same

mycelium, it may safely be assumed that no uredinia belong to the life-cycle. Furthermore, it rarely or never happens that teliospores of the *Uromyces-Puccinia* type, germinating immediately upon maturity, belong to genera with other spore forms in the life cycle, excepting the largely tropical genera of *Eriosporangium* and *Argotelium*.

Short cuts are also available in other directions. All gramineous and cyperaceous hosts bear rusts that may be assumed to possess all spore forms and are heterœcious, only one exception being positively known at present. Rusts on rosaceous hosts largely belong to the genera of the sub-family *Phragmidiatæ*, and on leguminous hosts largely to genera of the sub-families *Raveneliatæ* and *Uropyxidatæ*, and so on.

But probably one of the most efficient short cuts, and a wholly legitimate one, owing to the phylogenetically intimate relation of fungus and host among the rusts, will eventually be the consultation of a host index. In the present chaotic condition of taxonomic literature in this group no very comprehensive indexes exist, but they are likely to be provided in the early future. By this means it can be readily ascertained what species have been recognized upon the host in question, and from this list, usually small, not much difficulty will be experienced as a rule in locating the particular rust.

Another difficulty in using the new system will probably be felt in the much larger number of genera to be recognized. Some of these genera have been long known, but only partially accepted, and consequently little used, like *Pileolaria*, *Uropyxis*, *Trachyspora*, *Gymnoconia*, *Kuehneola*, *Eriosporangium*, and *Dasyspora*. Not being well understood, they have remained monotypic, or with only a few species each, although every one of these genera really contains more than one and some many species. Other genera have been established to receive species which show relationships quite different from those usually assumed for them. Thus, *Transzschelia* and its closely associated genera have many characters showing their close relationship with the *Ravenelia* group, and have only superficial resemblances to the *Puccinia-Uromyces* group in which they have heretofore been submerged. But probably the most striking innovation is the placing of like species under different genera, according as they possess all or part of the spore forms in their life cycle. At first thought this seems to be an appropriation of the Schroeterian biological classes, into which every genus was considered to be potentially divisible, *i. e.*, heteroforms, auteuforms, opsisforms, brachyforms, hemiforms, microforms, and leptiforms, and calling these classes genera. But in reality the basis of the segregates which I have recognized, for example, *Dasyspora* with teliospores, *Bullaria*, with urediniospores and teliospores, *Allodus* with aeciospores and teliospores, and *Dicaeoma* with all spore forms which take the

place of the genus *Puccinia* as now commonly used, rests upon a wholly different consideration, having to do fundamentally with the progressive evolution of the rusts, and not with adaptations. While space does not permit the presentation of an argument sufficiently full to demonstrate this proposition and carry conviction, yet it may be pointed out that while the genus *Dasyscypha* includes species, all of which have progressed in their evolution to the stage where the aeciospores and urediniospores have been effectively suppressed from the life cycle, yet it includes both leptofoms and microforms, according to their adaptations to the requirements of the environment, some species exhibiting only one or the other adaptation, and some assuming either form, now one, now the other, in accordance with conditions affecting growth not yet made clear. In the same way autoecism and heteroecism are regarded as adaptations, and not as an evolutionary development of generic rank. Having set up this principle, it becomes logical to separate *Gallowaya* from *Coleosporium*, *Chrysomyxa* from *Melampsoropsis*, *Macalpinia* from *Uromycladium*, *Dendroecia* from *Ravenelia*, *Calliospora* from *Uropyxis*, *Nyssospora* from *Triphragmium*, *Telospora* from *Nigredo*, etc. But it would be a wholly false impression to assume that this character of the suppression of spore forms is the only one separating the genus from the others of its group. It is the most prominent and the most easily stated, but in most cases will be found associated with other characters of acceptable value.

There is another argument beside that based upon phylogeny for the separation of species into genera as indicated above, and that is, convenience. It will lead, it is believed, to a better recognition of the various forms that go to make up each species, particularly valuable in the exploration of new or old floral regions, and also will permit clearer concepts in discussions relating to phylogeny, ecology, distribution, cytology, and a host of other problems. Even if there are those who do not admit the validity of the claim for true generic characters underlying the genera in question, they must accord the right to establish among the rusts, a group of organisms where parasitism of the most obligatory nature has constantly reduced the number of chances for displaying diversified characters, while increasing the physiological sensitiveness of the fungus to variations in the host, genera of this kind so long as they are as useful for the genuine increase of knowledge as have been the genera *Puccinia* and *Uromyces*, which are separated upon no better grounds than those advocated for the genera in question, if in fact as good, and no one, so far as the writer knows, has seriously insisted upon merging these two genera.

A few words may be said in regard to the nomenclature. The generic names have been chosen, such as are not new, in accordance with the American doctrine of types as applied in

the Philadelphia code. This course will doubtless be accepted as natural, whether considered best or not, seeing that the author was a member of the committee that drafted the code, and that he has on several subsequent occasions affirmed his belief in the essential validity of the principles which underlie the code. Granting the method of procedure, there is no need in this place to take up the question of the correct application of the several names; that may for the present be left to others. There are two names, that the establishment of types and application of the rule of priority have brought uppermost, *i. e.*, *Uredo* and *Aecidium*, which may lead to some confusion and inconvenience. Yet the number of species in the true genus *Uredo* and true genus *Aecidium* as distinguished from the form genera of these names, are so few, that the little inconvenience may be endured for the sake of correct method and final result. It is noteworthy that *Aecidium* as a genus name, supplied the basis, according to many authors, for the name of the order, while *Uredo* since 1825 has been chiefly employed in this way, and is now firmly established as the genus on which the order *Uredinales* is founded.

A word may be said by way of explanation regarding the method of citation. The manuscript was prepared in accordance with the American method, but the printed proof submitted showed an evident editorial intention to have it changed to the German method, an intention most imperfectly carried out by the compositor. The typographical errors may be ascribed to the intricacies of this transformation, which diverted attention belonging to legitimate proof reading.

There is one question which is likely to come up in the mind of the reader, which finds no answer in the published article, that is, regarding the status of such forms as are too imperfectly known to be placed with much confidence in any of the recognized genera. The author proposes in his own work to retain such names as *Peridermium*, *Cacoma*, *Roestelia*, *Uromyces* and *Puccinia* as form genera for imperfectly understood species, and even *Uredo* and *Aecidium* in their customary acceptance as form genera, if a better course does not become evident. These will constitute an *Anhang* for recording undistributed and imperfectly known forms.

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